ENERGY CONSUMPTION GUIDE 83

Energy use in Government Laboratories

ENERGY CONSUMPTION GUIDE 83

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY

BEST PRACTICE PROGRAMME

June 2002

Energy use in Government Laboratories

CONTENTS

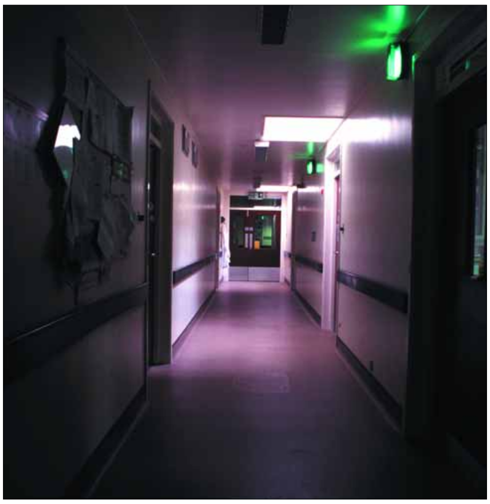
This Guide is published on behalf of Action Energy – formerly the Energy Efficiency Best Practice programme.

1 ABOUT THIS GUIDE

This Guide has been produced to help those with responsibility for reducing energy consumption within Government Laboratories.

It identifies the factors which influence the amount of energy used within laboratories and in the light of these:

- Defines energy consumption benchmarks for generic laboratory ‘types’, against which the performance of any particular laboratory can be measured.
- Highlights the key areas where energy savings can be made within most laboratories.
- Provides concise Case Histories demonstrating energy efficiency Good Practice within existing Government Laboratories.



2 TYPES OF LABORATORIES

When compared with most other building types within the civil estate (eg offices), the range of energy performance exhibited by laboratories is far more diverse. The type of equipment installed (and the intensity of its use), has a significant impact on a laboratory's energy use and this cannot be easily benchmarked.

Despite this great diversity, laboratories within the Government's civil estate can crudely be assigned into one of two generic types, namely:

- Type 1: Simple laboratories
- Type 2: Complex laboratories

The characteristics of these two types of laboratory are summarised as follows:

TYPE 1: SIMPLE LABORATORIES

Heating

Fossil fuel fired boilers provide heating to most areas of the laboratory. Typically, up to 10% of the total area may be heated electrically either via heat pumps or direct electric heating (for example in ancillary stand-alone buildings).

Ventilation

Type 1 laboratories are either naturally ventilated (often supplemented by local extractor fans), or mechanically ventilated by central air handling plant.

Air-conditioning/Cooling

Type 1 laboratories are not widely air-conditioned, but up to 33% of the total area may be cooled (typically using ceiling or wall mounted cassette units).

Laboratory Equipment

Type 1 laboratories house only basic laboratory equipment, principally:

- Fume cupboards
- Incubators
- Centrifuges
- Microscopes
- Refrigerated storage (typically 15-20 free-standing appliances and 1 walk-in cold store per 1,000 m^2 of floor area).
- Sterilisers/dishwashers

Specialist Equipment

Type 1 laboratories house little, or no, energy intensive specialist equipment.

Office Accommodation

Typically accounts for 25-40% of total floor area.

TYPE 2: COMPLEX LABORATORIES

The category of 'complex laboratories' is a broad one and encompasses all those laboratories which are significantly more energy intensive than those defined as Type 1. Reasons for this increased energy requirement may include:

- Process energy use such as an incinerator or the bulk water heating/pumping activities associated with some Centre for Environment, Fisheries and Aquaculture Science (CEFAS) laboratories.
- Widespread air conditioning (sometimes including humidity control).
- Widespread use of specialist analytical equipment (eg FTIR, ICP, NMR, mass spectrometry etc).

THE BENCHMARKS 3

The energy consumption benchmarks against which the energy performance of Government Laboratories should be compared are shown in Table 3.1. These are based on an analysis of data from 37 existing Government laboratories. Initially, all laboratories should strive to do better than the 'typical' benchmarks. The 'good practice' values show what can be achieved, particularly within new laboratories.

Table 3.1: Energy consumption benchmarks

	kWh/m^2 per year		
	Oil/Gas/Coal	Electricity	Total
Type 1: Simple laboratories			
Typical	211	124	335
Good Practice	160	110	270
Type 2: Complex laboratories	Site specific benchmark required (see below)		

Important Notes:

1 The benchmark figures quoted in Table 3.1 are based on the 'Treated Floor Area' ie the area that is heated.

Approximate conversions for typical laboratories are:

- Treated floor area = Agents letting area (ALA) x 1.25
- Treated floor area = Gross internal area (GIA) x 0.95

2 The benchmark figures quoted in Table 3.1 assume the following:

- Single shift occupation, Monday – Friday, with some limited activity over the weekend. Assumed occupation hours for the building (excluding cleaning and maintenance staff), are taken as 55 hours/week.
- Annual degree days of 2462.

Adjustments will be necessary where the conditions at a particular laboratory differ from these assumptions. See Section 4, for guidance on how to do this.

3.1 BENCHMARKS FOR COMPLEX LABORATORIES

The complex and unique characteristics of Type 2 laboratories means that it is impractical to formulate meaningful generic benchmark figures against which their performance can be measured. Their total energy consumption will typically lie between 500-1,000 kWh/m^2 per year, but little can be drawn from this fact due to the diverse range of equipment and activities that give rise to these higher consumptions. Alternative 'site specific' approaches are required to benchmark these complex laboratories. Three options are described below, the most appropriate for each site will depend on local circumstances.

Approach 1: Sub-meter 'process' energy use and treat the rest as a simple laboratory

Notwithstanding the much higher energy use associated with 'complex laboratories', many are in reality merely 'simple laboratories' with only one or two additional energy intensive activities. Under these circumstances, it may be possible to separately sub-meter these 'process' energy loads. Their consumption can then be subtracted from the site total, leaving a balance which can be compared with the 'simple laboratory' benchmarks.

THE BENCHMARKS

Examples of this approach include a number of the Veterinary Laboratories Agency's (VLA) laboratories which include incinerators. These incinerators are major energy users which fall outside the definition of equipment installed in 'simple laboratories'. The installation of sub-meters to the incinerator's gas (or oil) and electricity supplies allows them to be separately monitored. Incinerators apart, VLA labs are classic 'simple laboratories' and the residual 'non-incinerator' energy use can therefore be easily benchmarked.

It is worth noting that while process energy use should be treated separately from general laboratory energy use it is not 'uncontrollable'. Equally stringent efforts should be applied to improving the efficiency of process energy use, as good savings can be made.

Approach 2: Adopt previous performance as the benchmark

While sub-metering is a practical proposition where there are only one or two substantial process energy loads, many 'complex laboratories' achieve their status due to the more widespread use of less significant equipment such as FTIR, NMR etc.

Historical performance can be used as a benchmark for such sites.

The benchmark is calculated simply by dividing a typical 12 months' kWh consumption (for each fuel), by the site's treated floor area.

The resulting kWh/m^2/year figures must then be corrected to relate to the 'standard' conditions defined in Note 2, Table 3.1 namely:

- an occupation of 55 hours/week
- annual degree days of 2462.

This will make these benchmarks consistent with the others presented in this Guide, and will allow the methodology presented in Section 4 to be used to correct for any subsequent changes in working hours or weather conditions.

The equations for calculating benchmark figures based on historical performance are as follows, where:

Q_B = Annual energy consumption in base year (kWh)
A_B = Treated floor area during base year (m^2)
H_B = Weekly occupancy hours during base year (hours/week)
D_B = Degree days for base year
H_{CF} = Occupancy correction factor as listed in Table 3.2

Electricity Benchmark

$$\text{Benchmark (kWh/m}^2\text{/year)} = \frac{Q_B}{A_B} \times \frac{55}{H_B}$$

Fossil Fuel Benchmark

$$\text{Benchmark (kWh/m}^2\text{/year)} = \frac{Q_B}{A_B} \times H_{CF} \times \frac{2462}{D_B}$$

Table 3.2 Occupancy correction factors for fossil-fuel consumption

Occupancy Period	H_{CF}
Single shift, five days per week	1
Single shift, seven days per week	0.95
Continuous working (seven day week)	0.8

Approach 3: Undertake an Energy Survey to calculate a site specific benchmark

The methodology described in Approach 2 is a quick and easy way of establishing a site benchmark, but cannot provide any indication of the level of energy efficiency currently being achieved.

Approach 2 can therefore be usefully supplemented in due course by undertaking a detailed energy survey.

The results of the survey can be used to define the benchmark in one of two ways:

i) Top-down

The savings potential resulting from 'no cost' measures (such as more energy efficient working practices, control adjustments etc), can be subtracted from historical consumption levels to provide a benchmark for achievable performance.

ii) Bottom-up

The benchmarks for simple laboratories can be used as a basis, but with additional allowances made for any specialist equipment or more widespread use of air-conditioning.

It is anticipated that site-specific benchmarks should only prove necessary at around 10 or so Government Laboratories and in view of their relatively high energy use, the effort involved in surveying should be justified.

Detailed advice on undertaking in-house energy surveys and/or employing specialist consultants is provided in Good Practice Guide 311 'Detecting Energy Waste – a guide for energy audits and surveys in the Government Estate.'

3.2 ALLOWANCES FOR SPECIALIST LABORATORY EQUIPMENT

The 'bottom-up' approach described above, requires an inventory to be made of all specialist laboratory equipment that falls outside that normally found in Type 1: Simple laboratories (see earlier definitions). A typical annual energy consumption will then need to be allocated to each item and a corresponding kWh/m^2/year allowance added to the Type 1: Simple Laboratory benchmark. In this way a more representative benchmark can be calculated for the complex laboratory concerned. This same approach can be used to gain an understanding of hours consumption should change in response to the future addition or removal of laboratory equipment.

Standard Allowance

In the absence of more detailed information, allow 5000 kWh/year for each piece of single-phase electrical equipment that is left switched on for the majority of the laboratory's occupied period.

Ideally though, a more accurate assessment should be made using one of the methodologies described below. This should also be used to estimate the consumption associated with all three-phase electrical equipment.

Two pieces of information will be required to derive a representative value for the annual energy use for each item of equipment, namely:

i) annual hours of use

ii) typical power consumption (kW)

It should be noted that some items of laboratory equipment (particularly analysers), need to be left 'on' continuously to maintain stable operating conditions. In these circumstances it may be appropriate to consider the 'working' and 'idle' periods separately.

The typical power consumption can itself be identified in two ways:

i) reference to manufacturer's data

ii) direct measurement

Manufacturer's data

Most laboratory equipment is supplied with a handbook, which may well include data on electrical loads (both 'working' and 'idle').

Failing this, all equipment should have a nameplate attached to it which will state its maximum power consumption or current (Amps). It should be noted, however, that these nameplate ratings are usually larger than the actual power consumption that occurs in use. In the absence

THE BENCHMARKS

of any better information, therefore, the following should be assumed:

- 'working' electrical load = 0.5 x nameplate rating
- 'idle' electrical load = 0.25 x nameplate rating

Where only electrical current data is available, this can be converted approximately to kW by:

a) single-phase equipment:

$$kW = \frac{\text{Current (Amps)} \times 230 \times 0.9}{1000}$$

b) three-phase equipment:

$$kW = \frac{\text{Current (Amps)} \times 400 \times 0.9 \times 1.732}{1000}$$

Direct Measurement

Direct measurement of power consumption is a preferable alternative to relying on nameplate ratings, but care must be taken to ensure that the readings are representative of normal use.

A simple plug-in Watt meter can be used to measure power used by single phase plug-in equipment (the meter plugs into the 13A wall socket, and the equipment is then plugged into the meter). Hard-wired single and three-phase equipment will require the services of an electrician to perform a 'tongue test' using a clip-on ammeter.

3.3 DEALING WITH AIR-CONDITIONING

The benchmarks presented for Type 1: Simple laboratories include an allowance for up to 33% of the treated floor area to be air-conditioned.

If the percentage air-conditioned is greater than this, an appropriate addition must be made to the electricity benchmark. This adjustment should be made after any other additions have been made for specialist equipment (as discussed in the preceding sections).

Multiplying factors from Table 3.3.should be used.

% of treated floor area that is air-conditioned	Multiplying factor for electricity benchmark
33	1.0
40	1.03
50	1.06
60	1.09
70	1.13
80	1.17
90	1.20
100	1.24

Note that no adjustment should be made to the fossil fuel benchmark.

Table 3.3. Air-conditioning factors

Example:

To calculate the benchmarks for a fully air-conditioned laboratory that would otherwise be classified as 'simple', take benchmarks from Table 3.1 and correct as follows:

Electricity: Typical benchmark = 124 kWh/m^2/year
Multiplying factor for 100% air-conditioning = 1.24
Corrected benchmark therefore
124 x 1.24 = 154 kWh/m^2/year

Fossil fuel: No corrections necessary, take Typical benchmark = 211 kWh/m^2/year

HOW TO CALCULATE THE ENERGY PERFORMANCE OF LABORATORY BUILDINGS

4

To make use of benchmarks it is important to adjust raw energy consumption data to the same basis as the benchmarks in order to make a like-for-like comparison. There are five major steps. A worked example is given at the end of this section.

Step 1

Convert energy units to kWh

Electricity is already measured in kWh but other types of fuel must be converted to kWh so that a common energy unit is used. Conversion factors from Table 4.1 can be used.

Table 4.1 Fuel conversion factors

Fuel	Measured Units	To get to kWh, multiply by
Electricity	kWh	1.0
Natural gas	m^3	10.7
	kWh	1.0
	100 ft^3	30.3
Gas Oil (35 sec)	Litres	10.6
Light fuel oil (290 sec)	Litres	11.2
Medium fuel oil (950 sec)	Litres	11.3
Heavy fuel oil (3500 sec)	Litres	11.4
LPG/Propane	Tonnes	13 780
Coal	kg	9.0

Step 2

Adjust the space-heating energy (fossil fuel) to account for the weather

When the weather is severe a building will use more energy. In order that a reasonable comparison can be made with data from different years, a correction factor is applied. There is an outside temperature called the base temperature (taken to be 15.5°C for most buildings), above which heating is not necessary because of internal heat gains from people, equipment, lighting and solar gain. The space-heating requirement is dependent on the number of ‘degree days’.

As an example, if for one week the average outside air temperature was 12.5°C, this would represent a heating requirement for the building (15.5 – 12.5) x 7 = 21 degree days.

In order to calculate the weather correction factor, the total degree days for a standard year are divided by the degree days for the year in which the energy data is to be considered. The standard year is taken to have characteristics that are typical of the last 20 years’ average for the UK and this totals 2462 degree days.

$$\text{Weather correction factor} = \frac{\text{Standard degree days (2462)}}{\text{Degree days for energy data year}}$$

All the benchmark figures in this Guide have been calculated from sites throughout the UK. To obtain a standard benchmark they have all been adjusted to standard degree days. For this reason, it important to weather-correct the space-heating element of energy consumed so that calculated performance for any site in kWh/m^2/annum is compared with the benchmark on a like-for-like basis. For simplicity, the space heating element is assumed to be all of the fossil-fuel energy use (less any major process use that is separately sub-metered).

Monthly degree days are published for standard regions of the UK.

HOW TO CALCULATE THE ENERGY PERFORMANCE OF LABORATORY BUILDINGS

Step 3

Occupancy correction

The benchmarks for simple laboratories relate to 55 hours/week occupation. If these hours vary, then a correction factor must be applied both to the fossil-fuel and electricity consumption.

For electrical energy performance the adjustment should be made on a pro rata basis for the hours occupied. For fossil fuels, a separate correction factor is required. For the purpose of this Guide the correction factors shown in Table 4.2 should be used.

Table 4.2 Occupancy correction factors for fossil-fuel consumption

Occupancy Period	Correction Factor
Single shift, five days per week	1
Additional 15 hours per week, eg weekend working	0.95
Continuous working (seven-day week)	0.8

Step 4

Determine the floor area

Floor area is defined as:

- **Gross internal area** – total building measured inside external walls
- **Treated floor area** – gross areas, less plant room and other areas not directly heated (eg Stores, covered car parking and roof spaces).
- **Agents letting area** – useable internal space (ie excluding circulation areas etc).

In multiple-storey buildings, areas are floor areas for each floor.

The benchmarks presented in this document are based on Treated Floor Area, and so if the data for a particular laboratory is only available in a different form it must be converted. Typical conversion factors are listed in Section 3.

Step 5

Calculate performance indicators

Performance indicators for fossil fuel and electricity can now be calculated.

$$\textit{Fossil-fuel performance indicator} = \frac{\text{Corrected annual fossil-fuel consumption}}{\text{Treated floor area}} = \text{kWh/m}^2\text{/annum}$$

$$\textit{Electricity performance indicator} = \frac{\text{Corrected annual electricity consumption}}{\text{Treated floor area}} = \text{kWh/m}^2\text{/annum}$$

These performance indicators can then be compared with the benchmarks for the relevant laboratory category.

Worked example

Building type:	Type 1: Simple laboratory
Degree days:	2253
Treated floor area:	3,500m^2
Weekly hours of use:	70
Annual electricity consumption:	553 797 kWh/annum
Annual gas consumption:	784 162 kWh/annum

Step 1

Convert energy units to kWh.

Not required.

Step 2

Adjust the space-heating energy (fossil fuel) to account for the weather

The degree day factor is $\frac{2462}{2253} = 1.09$

Corrected gas usage is 1.09 x 784 162 = 854 737 kWh

Step 3

Occupation correction

Correction factor for electricity is $\frac{55}{70} = 0.79$

Correction factor for gas is 0.95 (see Table 4.2)

Step 4

Determine the floor area

Treated floor area = 3500m^2

Step 5

Calculate performance indicators

Fossil-fuel performance = $\frac{854\ 737 \times 0.95}{3500} = 232$ kWh/m^2/annum

Electricity performance = $\frac{553\ 797 \times 0.79}{3500} = 125$ kWh/m2/annum

Compare actual with benchmark performance, as shown in Table 4.3.

	Actual performance (kWh/m^2/annum)	Benchmark performance (kWh/m^2/annum) (see table 3.1)	Improvement needed
Electricity	125	124	1%
Fossil Fuel	232	211	9%

Table 4.3 Comparing actual with benchmark performance

5 BENCHMARKING OF MULTI-BUILDING SITES

The majority of Government Laboratories are housed in single buildings, but there are also a few multi-building sites.

If possible, all significant buildings (typically those with a floor area above 1000 m^2), should be separately sub-metered to allow each one's performance to be measured against an appropriate benchmark. Similarly, energy intensive 'processes' should also be sub-metered as previously discussed. To help this process, sub-metering should be specified on all new and refurbishment building projects.

Where submetered data is lacking, it is possible to model overall site energy consumption using individual building floor areas and benchmarks. The calculated total benchmark consumption for fossil fuel and electricity can then be compared with actual consumption data from main meter readings. The methodology for this approach is shown in Figure 5.1 and worksheets 5.1 and 5.2 (page 5-3).

This approach requires that each building is categorised into an appropriate type, for which published benchmarks are available (for example, simple laboratories, offices, stores etc).

Table 5.1 lists the benchmark figures currently available for non-laboratory building types relevant to large laboratory sites.

Specialist buildings (such as greenhouses), do not lend themselves to generic benchmarks due to the

Figure 5.1 Methodology of benchmarking multi-building sites

1. Measure the treated floor area of each building or obtain data from an asset register
2. List buildings by their area in m^2 and categories
3. List benchmarks for each category where appropriate
4. Multiply benchmarks by areas for each category for fossil fuel and electricity
5. Add in other energy use (eg district heating mains losses, security/car park lighting)
6. Calculate benchmark energy usage for site for fossil fuel and electricity using worksheet 5.1 and 5.2
7. Adjust actual usage for weather and occupancy, to benchmark standard conditions
8. Compare calculated benchmark usage against actual annual usage for fossil fuel and electricity
9. Estimate the scope for savings if benchmark figures were not reached. Identify priority areas for further investigations

BENCHMARKING OF MULTI-BUILDING SITES

Table 5.1 Benchmarks for Non-Laboratory Buildings

	kWh/m² per year		
	Oil/Gas/Coal	Electricity	Total
Offices, natural vent, cellular			
Typical	151	54	205
Good Practice	79	33	112
Offices, natural vent, open plan			
Typical	151	85	236
Good Practice	79	54	133
Offices, air conditioned			
Typical	178	226	404
Good Practice	79	128	225
Workshops			
Typical	244	80	324
Good Practice	175	29	204
Motor transport facilities			
Typical	353	33	386
Good Practice	317	20	337
Stores/warehouses, occupied			
Typical	229	47	276
Good Practice	187	34	221
Stores/warehouses, unoccupied			
Typical	76	7	83
Good Practice	54	3	57

unique uses to which they are put. These buildings should therefore ideally be separately submetered and bespoke benchmarks created for them based on operating experience.

In some situations a degree of sub-metering may already exist and this will clearly help to identify buildings with the greatest potential for savings. However, where electricity sub-metering does not exist, it may be necessary to use portable electric meters. Each large site and energy manager should have access to this equipment. Where the equipment is not available it should be obtained as a matter of priority and if outright purchase is difficult, in the short term, it should be either hired or borrowed.

Having used the benchmarks to calculate individual building energy use, it is important to add any energy not attributable to the buildings themselves, eg heat losses in district heating distribution systems, street lighting etc.

On sites with a district heating system, distribution heat losses must be accounted for in the fossil fuel benchmark and can be considerable. The heat loss from district heating systems is usually directly related to the design capacity of the system so the losses are proportionately higher at low loads, eg during the mild periods during the spring and autumn.

A study of MoD district heating systems has yielded a rule of thumb of 40% (±2%) for annual distribution losses for most large systems. For smaller systems (eg boiler supplying six buildings in close proximity to each other) the losses might be 25%. These figures are sufficient for estimates in this procedure.

Electricity for external purposes, security lighting for perimeter fences, car parks and street lighting must be accounted for. The load can be estimated by examining the installed load and hours of annual usage. Typical usage would be 4300 hours per annum, but this figure will vary for different parts of the UK.

Worksheets 5.1 and 5.2 illustrate this approach.

BENCHMARKING OF MULTI-BUILDING SITES

Worksheet 5.1 Calculation of fossil fuel benchmark consumption

A	B	C	B x C	
Building Category	**Typical Fossil-fuel benchmark ($kWh/m^2/year$)**	**Treated floor area (m^2)**	**Calculated benchmark for annual fossil-fuel usage (kWh)**	
Simple laboratories	211	22 000	4 642 000	
Complex laboratories	Sub-meter or survey	–	–	
Offices Nat vent cellular	151	2500	377 500	
Nat vent open plan	151	–	–	
Air conditioned	178	–	–	
Workshops	244	–	–	
Motor transport facilities	353	1500	529 500	
Stores Occupied	229	–	–	
Unoccupied	76	–	–	
Specialist buildings	Sub-meter or survey	–	–	
Sub-total		26 000	**5 549 000**	D
Distribution losses (if district heating)		0.4 x D =	2 219 600	E
Total fossil fuel use (D+E)			**7 768 600**	

Worksheet 5.2 Calculation of electricity benchmark consumption

A	B	C	B x C	
Building Category	**Typical electricity benchmark ($kWh/m^2/year$)**	**Treated floor area (m^2)**	**Calculated benchmark for annual electricity usage (kWh)**	
Simple laboratories	124	22 000	2 728 000	
Complex laboratories	Sub-meter or survey	–	–	
Offices Nat vent cellular	54	2500	135 000	
Nat vent open plan	85	–	–	
Air conditioned	226	–	–	
Workshops	80	–	–	
Motor transport facilities	33	1500	529 500	
Stores Occupied	47	–	–	
Unoccupied	7	–	–	
Specialist buildings	Sub-meter or survey	–	–	
Sub-total		24 600	**2 912 500**	D
Security lighting	installed load (12.5 kW) x 4300 =		53 750	E
Total electricity use (D+E)			**2 966 250**	

RESPONDING TO POOR PERFORMANCE 6

It is possible to use benchmarks to help with the initial 'detective work' when analysing the energy performance of a building. This is a particularly useful technique that can help to establish priorities or identify areas for further investigation.

Usually, it is worthwhile examining not just the benchmark for the whole building but the separate benchmarks for the fossil fuel and electricity, and their components. Additionally, if areas of the building are sub-metered, calculating the energy performance for these areas can also be helpful. There is clear evidence, however, that laboratories with a high electricity consumption have a correspondingly lower fossil fuel consumption (and vice versa), and this effect should be expected.

Table 6.1 presents the expected breakdown of energy usage (kWh/m^2 per year) within 'simple laboratories'.

With 'complex laboratories', the contribution from 'laboratory equipment' can be much more significant, and 'cooling' will be larger if more extensive use is made of air-conditioning. The contribution from 'lighting' is unlikely to vary much however.

Fossil fuel use in 'complex laboratories' can often be less than in 'simple laboratories', as the higher gains from electrical equipment reduces the need for space heating.

Further analysis of a building's half-hourly electrical demand profiles (typically available from your electricity supplier for sites with a maximum demand greater than 100 kW and sometimes for smaller sites), or night-time electricity demand compared with the daytime usage, etc, can help to maximise the benefits from site investigation. This type of analysis can indicate areas of wastage, or even the specific time of day that requires further investigation.

	Typical	Good Practice
Heating and hot water (fossil fuel)	211	160
Heating and hot water (electrical)	8	7
Cooling	15	13
Pumps and fans (incl. fume cupboards)	14	13
Lighting	20	18
Office equipment	3	3
Laboratory equipment	25	22
Refrigerated storage	39	34
Total fossil fuel	**211**	**160**
Total electricity	**124**	**110**
Total kWh/m^2 per year	**335**	**270**

Table 6.1 Breakdown of energy use within 'simple laboratories' (kWh/m^2/year)

RESPONDING TO POOR PERFORMANCE

The figure 6.1 below shows a typical weekly electrical demand profile for a laboratory working single shifts. The weekday peaks in consumption can be clearly seen. Detailed examination of the data might prompt the following questions:

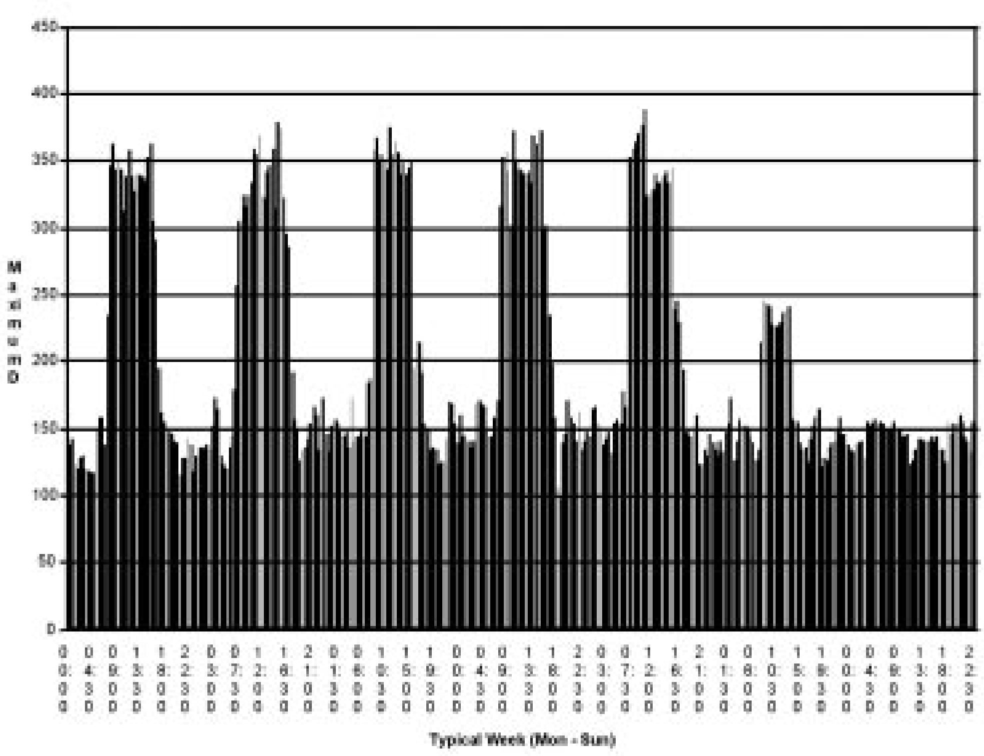
- **How quickly and effectively are lights and laboratory equipment being turned off at the end of the working day?**
- **Is the use of electricity on Saturday legitimate?**
- **Why is there such a substantial residual over-night electrical load?**

If a step change is noted in energy performance (either up or down), this may have been legitimately caused by changes in local conditions. These changes could include:

- Longer or shorter working hours.
- Warmer or colder weather (degree days).
- Increases or reductions in the amount of laboratory equipment.
- New buildings or demolitions (on multi-building sites).

The methodologies for accounting for each of these are presented earlier in this Guide.

Figure 6.1 Typical weekly electrical demand profile for a laboratory working single shifts



7 SAVINGS OPPORTUNITIES

Savings are potentially available across the full range of laboratory energy uses. Information Sheets are included at the rear of this Guide which describe the principal savings opportunities in the following areas:

Information Sheet 1: Boilers and boiler control
Information Sheet 2: Heating controls
Information Sheet 3: Domestic hot water
Information Sheet 4: Lighting
Information Sheet 5: Air-conditioning
Information Sheet 6: Water usage
Information Sheet 7: Staff awareness campaign
Information Sheet 8: Good housekeeping
Information Sheet 9: Refurbishments
Information Sheet 10: Laboratory equipment
Information Sheet 11: Check list

Each opportunity is keyed to indicate whether it is:

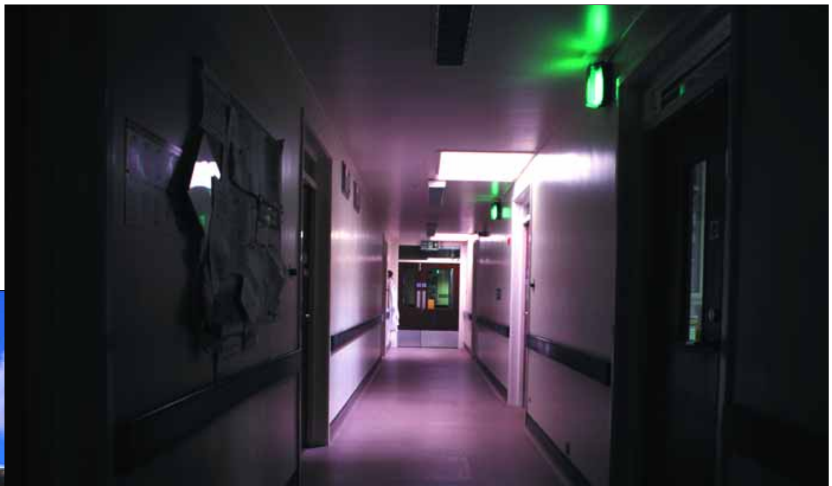
- A no-cost measure, capable of easily being carried out by competent staff.
- Servicing/repair of plant or equipment.
- A low-cost item, funded at local level (often self-funded).
- A high-cost measure, likely to require capital funding (eg from a departmental budget).

In all cases, priority should be given to the simple no-cost and low-cost opportunities (for example turning lights off when not required). Individually, these issues can appear insignificant, but it is often easier, for example, to identify 20 small saving measures each worth 0.5%, than one large measure worth 10%.

This attention to detail is important and can cumulatively yield dramatic results, as shown by Case History 1, VLA Bury St Edmunds.

Investment in energy efficient technologies does, of course, also have an important part to play, particularly when new laboratories or refurbishments are being planned. The application of some of these technologies is illustrated in Case History 2, CEFAS Weymouth.

Corridor showing green 'tell-tale' lamp for cooling unit in neighbouring laboratory



VLA Bury St Edmunds

SAVINGS OPPORTUNITIES – VLA BURY ST EDMUNDS

Case History 1 – VLA Bury St Edmunds

The Veterinary Laboratories Agency's lab in Bury St Edmunds is a single building, built in the mid 1990s and has a treated floor area of approximately 2000 m^2. The laboratory manager has embraced the concept of energy saving through the elimination of waste, and works closely with his colleagues to identify and implement schemes.

As a comparatively modern building, the laboratory and its services are inherently energy efficient and there are therefore limited opportunities for savings via capital investment in new plant (boilers, lighting etc). Instead the laboratory staff have concentrated on their working practices, supported by low cost enhancements where appropriate.

Their starting point was the acquisition of relevant energy consumption data. The site has a gas fired incinerator and it was quickly recognised that its use (which is variable and unpredictable), would dominate and distort the lab's overall energy use. Accordingly, sub-meters were fitted to the incinerator's gas and electricity supplies. These are read monthly (along with the main supply meters), by the resident FM contractor. Monthly consumption figures are calculated for both the incinerator and residual laboratory use, the results being plotted graphically for management information.

A detailed review of operations was also undertaken (in fact this is an on-going process at Bury St Edmunds), which identified a number of savings opportunities including those listed (page 7-3).

As a result of these actions (and others), VLA Bury St Edmunds' 1999/2000 total energy performance indicator (excluding incinerator use), was 271 kWh/m^2, which is virtually at the 'Good Practice' level of 270 kWh/m^2.

More dramatically, there are other VLA laboratories built at the same time as Bury St Edmunds and to the same design. One of these has a corresponding total energy performance indicator of 419 kWh/m^2.

The fact that VLA Bury St Edmunds can use 35% less energy than an identical building is entirely down to its managers' rigorous attention to working practices and the limited investments described above.

Strip curtain applied to walk in cold store

SAVINGS OPPORTUNITIES – VLA BURY ST EDMUNDS

Opportunity	Solution
Lighting left on in laboratories over tea and lunch breaks.	Staff awareness training and 14 light switches relocated to ease use.
Split a/c cooling units operating in competition with heating system.	Set-points adjusted to create 'dead band' between heating and cooling.
Cooling units left on unnecessarily overnight.	Large 'tell tale' lights installed in corridor to show when cooling units are on.
Steam generator left active even when sterilisers not in use.	Operations are logged daily and monitored to identify excessive usage.
Laboratory generally too hot in winter.	Heating sensor relocated to more appropriate position and thermostatic radiator valves (TRVs) added in some areas.
Lighting left on in toilets.	Movement sensor controls fitted.
External lighting on throughout the night (under photocell control)	Timeswitch added to turn car park lights off when staff have gone home (security lighting remains on).
Excessive external lighting.	Removed bulbs from 50% of bulkhead fittings.
Excessive internal lighting.	Selectively removed tubes from fluorescent fittings in non-critical areas.
Heat losses from steam pipework (by sterilisers).	Pipe insulation added (safety benefit also).
Cold air losses from walk-in cold stores when doors open.	Plastic strip curtains added and large light flashes when door is open to encourage its closure.
Incinerator run frequently for small loads.	Additional storage bins purchased to allow short term storage of material prior to incineration. Allows incinerator to be lit on fewer days, but dealing with larger loads (which is more efficient).
Ventilation plant and lighting left on in post mortem room.	Movement sensor controls added to turn lights off and set-back ventilation to slow speed when room is vacant.
Tea boiler left on continuously.	Plug-in timeswitch fitted.

Plug in timer for tea urn

SAVINGS OPPORTUNITIES – CEFAS WEYMOUTH

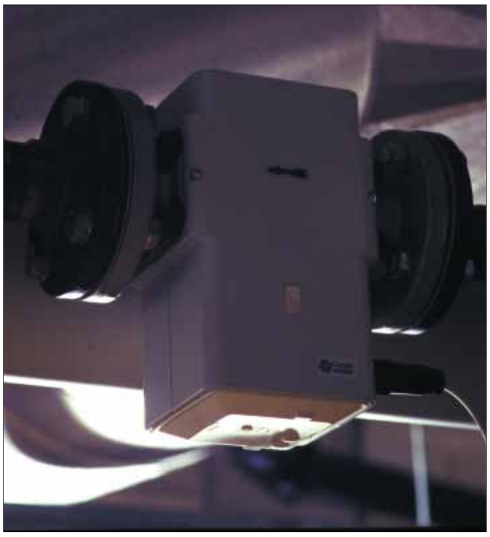
Case History 2 – CEFAS Weymouth

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) laboratory at Weymouth is a unique establishment with large tanks capable of housing fresh and salt water fish under closely controlled conditions.

Their operations involve large amounts of water pumping, heating and cooling in order to provide the required tank conditions. In addition, artificial lighting is needed to simulate differing hours of daylight.

As a result, CEFAS Weymouth must be considered a 'complex laboratory' and this is confirmed by a 1999/2000 total energy performance indicator of 790 kWh/m^2.

Whilst the laboratory does have substantial unique specialist facilities, these are supported by more general laboratory and office space which on its own would be classified as a 'simple laboratory'. The opportunity therefore potentially exists to separately sub-meter the fish tank facility and to benchmark the remaining areas separately.



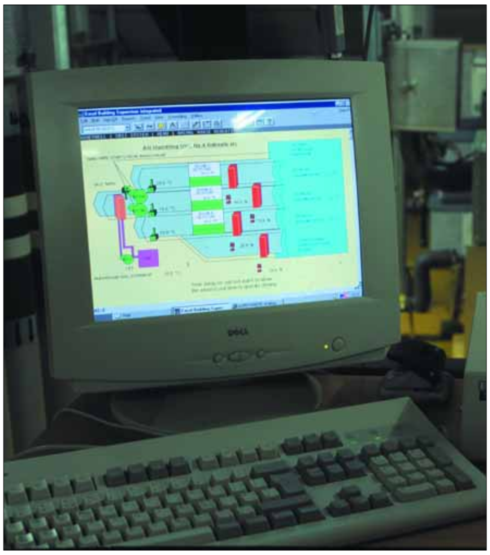
The Heat Meter

Sub-metering of electricity usage is usually straightforward, but heat can be more difficult. For example, at Weymouth the hot water supplied to heat the fish tanks comes from the same gas fired boilerplant that provides space heating to the laboratory building. To allow a split to be made, the laboratory uses a 'heat meter' which records the amount of heat delivered to the tank heating

CEFAS Weymouth

The Three Condensing Boilers

SAVINGS OPPORTUNITIES – CEFAS WEYMOUTH



The BEMS Workstation

main. This works by recording the volumetric flow and electronically combining this with accurate measurements of the supply and return temperatures to calculate the heat delivered.

The laboratory was opened in 1995 and has sophisticated services including full air-conditioning (with humidity control), to some areas.
In recognition that the laboratory would be a high energy user it has been equipped with highly efficient plant and equipment. Key features include:

- Condensing boilers – there are roughly 10% more efficient than conventional, non-condensing types but do cost more. Accordingly, whilst Weymouth has 11 modular boilers, only three are condensing models. These operate continuously as the 'lead' boilers to meet the site's year round tank heating loads. The non-condensing boilers come on line successively during the winter as the building heating load increases.
- Building Energy Management Systems (BEMS) – the building's many heating and ventilation controls are integrated into a single electronic system which can be accessed by the FM Contractor via a site based PC. This allows sophisticated control algorithms to be used, as well as allowing monitoring and control adjustment (on an individual room basis), to be done from a central point.
- Plate Heat Exchangers (PHE) – hot water is generated instantaneously using a number of PHE's. These eliminate the standing heat losses associated with large traditional hot water storage calorifiers and reduce the stringent hygiene requirements needed to control legionella infection.

A Plate Heat Exchanger

FURTHER INFORMATION

The following publications are available from Action Energy – (formerly the Energy Efficiency Best Practice programme).

ECON 75 'Energy use in Ministry of Defence establishments'
ECON 82 'Energy use in court buildings'
GPG 84 'Managing and motivating staff to save energy'
GPG 117 'Energy efficiency in the Government Estate – for accommodation managers
GPG 118 'Managing energy use. Minimising running costs of office equipment and related air-conditioning'
GPG 276 'Managing for a better environment. Minimising running costs and impact of office equipment'
GPG 310 'Degree days for Energy Management – a practical introduction'
GPG 311 'Detecting energy waste – a guide for energy audits and surveys in the Government Estate'
GPG 312 'Invest to save? Financial appraisal of energy efficiency measures across the Government Estate'
GPG 320 'Energy efficient operation and design of fume cupboards'

FURTHER READING

Chartered Institution of Building Services Engineers (CIBSE)

- Applications Manual (AM) 5. Energy Audits and Surveys CIBSE, London, 1991
- CIBSE Guide. Energy Efficiency in Buildings. CIBSE, London, 1998

This document is based on material drafted for Action Energy by Briar Associates under contract to the BRE's Sustainable Energy Centre (BRESEC).

Action Energy – formerly the Energy Efficiency Best Practice programme – provides impartial, authoritative information on energy efficiency techniques and technologies in industry and buildings. This information is disseminated through publications, videos and software, together with seminars, workshops and other events. Publications within the programme are shown opposite.

Visit the website at **www.actionenergy.org.uk**

Call the Action Energy Helpline on **0800 585794**

Energy Consumption Guides: compare energy use in specific processes, operations, plant and building types.

Good Practice: promotes proven energy-efficient techniques through Guides and Case Studies.

New Practice: monitors first commercial applications of new energy efficiency measures.

Future Practice: reports on joint R&D ventures into new energy efficiency measures.

General Information: describes concepts and approaches yet to be fully established as good practice.

Fuel Efficiency Booklets: give detailed information on specific technologies and techniques.

Introduction to Energy Efficiency: helps new energy managers understand the use and costs of heating, lighting, etc.

1

BOILERS AND BOILER CONTROL

typical saving opportunities

Combustion

When monitoring combustion, the aim is to achieve the minimum excess air required for complete combustion of the fuel. This involves ensuring that the CO_2 content of the flue gas is the maximum possible and the oxygen (O_2) content is the minimum possible for a given firing rate, consistent with maintaining a smoke-free stack. The flue-gas temperature should be as low as possible without causing condensation of moisture and sulphur oxides.

Key saving

Regularly monitor boiler combustion efficiencies and set target efficiencies for the servicing contractors.

Boiler installation

The heat loss due to radiation from a modern boiler may represent only 1.5% of the boiler's output at full load, but will increase to about 6% if the boiler is operating at only 25% load.

Key saving

Insulate poorly insulated boiler plant.

Off-line flue losses

The installation of a flue-gas damper or a fully closing damper on the burner will minimise the convection heat losses through a boiler when it is not firing.

Key saving

Prevent convection losses through boiler.

Boiler sequencing

The highest boiler efficiencies typically occur between 70% and 90% of the rated firing capacity. Therefore, the boiler efficiency should be kept high by firing the boilers in this range for as much time as possible. Effective boiler sequence control enables only the minimum number of well-loaded boilers to operate to meet the system demand.

Key saving

Use boiler sequencer on multiple boiler installations.

This Information Sheet forms part of ECON 83 ‘Energy use in Government Laboratories’ and has been produced by BRE’s Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

HEATING CONTROLS

2

TIME CONTROL

Time switches

These bring the plant on and off according to set times of the day. These simple devices should only be used for installations below 100 kW. A resolution of better than 15 minutes should be used and a seven-day time switch should be used where occupancy hours differ between weekdays and weekends.

Optimisers

Optimiser controls are suitable for most intermittently heated buildings with an installed heating capacity greater than 100 kW.

Key saving

Ensure that time settings match the occupancy requirements and on larger installations use an optimiser.

Compensators

In a compensated system the flow temperature in the heating circuit is controlled relative to the external temperature. If a building is frequently overheated then the compensator slope may need adjusting.

Key saving

Check compensator settings.

Night set-back temperature

The night set-back temperature is the heating set point for periods outside normal occupancy times. For most office buildings in the UK, a night set-back of approximately 10°C is sufficient.

Key saving

Check night set-back temperature is appropriate.

Local controls

Where local controls are fitted eg thermostatic radiator valves (TRVs), zone valves, etc, it is important that their correct operation is checked as a minimum at the beginning of each heating season. Where TRVs are installed ensure that they are used correctly and not left on 'max'.

Key saving

Check operation of local controls.

Heating systems

All heating systems should be checked at least once per heating season (but preferably twice, once at the start and then again at the middle of the season) by utilising independent (ie not BMS-associated boiler controls that lend themselves to interrogation) portable instruments. These can be simple mechanical devices such as thermoscripts or electronic devices requiring a PC interface. Essentially they should provide a copy (hard or electronic) of the performance of the heating or air-conditioning systems showing the on/off times and space temperatures attained, over a period of, say, 2 weeks. Dependent on the recordings received, controls should then be re-set as shown to be necessary.

Key saving

Check operation of local controls.

typical saving opportunities

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

3

DOMESTIC HOT WATER (DHW)

Central or decentralised DHW production
During the summer months up to 90% of the energy used for providing hot water from central boiler/calorifier systems can be due to losses and inefficient generation. Considerable savings can be made by totally segregating generation of hot water from the heating system or by decentralising hot water provision to point-of-use systems.

Key saving
Consider decentralising hot water provision.

Direct-fired water heaters
These units are inherently more efficient than boiler/calorifier systems as the water is heated directly. The potential for savings by the correct application of direct-fired water heaters is up to 50%.

Key saving
Consider direct-fired water heaters.

Electric water heating
Large storage cylinders that are fitted with electric immersion heaters and built-in thermostats should be time-controlled as required. It is important to take advantage of any night-rate electricity tariff to minimise running costs.

Key saving
Ensure correct time and temperature control of immersion heaters.

Point of use electric water heaters can be very economical. It is, however, important to apply time controls to units that have high standing losses ie the casing is hot to touch.

Key saving
Fit seven-day time controls where standing losses are high.

Standing losses
Hot water storage and distribution systems should be adequately insulated to prevent high standing losses.

Key saving
Ensure all lagging is in good condition and thick enough.

Time controls
In intermittently occupied buildings, hot water storage and distribution systems should be time-controlled. It is, however, important to avoid legionella formation and that the time settings match occupancy (for full guidance see CIBSE Technical Memorandum 13). This may necessitate the use of a time switch separate to that used for controlling the building's heating.

Key saving
Ensure good time and temperature control of DHW that matches demand patterns.

Tea points
Due to the high standing losses from electric tea-point water boilers, time controls should always be fitted.

Key saving
Ensure all electric water boilers are time-controlled by seven-day time switches.

This Information Sheet forms part of ECON 83 ‘Energy use in Government Laboratories’ and has been produced by BRE’s Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

LIGHTING

Lamp efficacy*

Filament lamps (eg normal light 'bulbs') are the most inefficient type of light source as evidenced by the waste heat they produce. As such, filament lamps generally have a low efficacy.

Discharge lamps (eg fluorescent tubes, sodium lamps, etc) are between four and fifteen times more efficient than filament lamps.

Where possible, use high-frequency fluorescent light fittings as they have a higher efficacy than standard fluorescent fittings.

Key saving

Use the highest-efficacy lamp possible eg use compact fluorescent lamps in place of tungsten filament lamps.

*** Note:** Lamp efficacy is the lumens output for the consumed electrical energy (Watts). Filament (incandescent) lamps are of low efficacy because their lumens output is relatively low compared to the electricity consumed. Fluorescent lamps have a higher efficacy than filament lamps, producing more lumens output for a lower electrical consumption.

Manual lighting control

Switching arrangements should at least permit individual rows of luminaires parallel to windows to be controlled separately. Switches should be located as near as possible to the luminaires that they control. If groups of switches are used, simple labels should aid manual control.

Key saving

Encourage manual control of lighting wherever possible.

Automatic lighting controls

Photoelectric control ensures that lighting will be turned off when the daylight provides the required illuminance. Where high-frequency fluorescent lighting is installed, consider using photoelectric controls to dim the light output when ambient light levels allow.

Proximity controls are designed to respond to the presence or absence of occupants.

Key saving

Install automatic lighting control wherever viable.

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

AIR-CONDITIONING AND MECHANICAL COOLING

5

Air-conditioning is the combination of refrigeration and humidity control (often within a warm air heating system), that provides air that meets certain quality parameters. Mechanical cooling provides temperature control only (via refrigeration plant), and is frequently applied on a room-by-room basis using ceiling or wall mounted cassette units.

There are a number of key questions that need to be considered when operating air-conditioning or mechanical cooling:

- Is air-conditioning actually necessary or would improved ventilation be adequate?
- Can 'free-cooling' by outside air be provided for some of the year instead of mechanical cooling?
- Is it possible to separate all-year cooling requirements, such as communication equipment, from summertime-only comfort-cooling requirements?
- Can cool air be recovered in the summer as well as hot air being recovered in the winter?

Time control

Time control of air-conditioning plant is very important. This control must apply to all elements of the system ie the refrigeration plant, fans, pumps, humidifiers etc.

Key saving

Ensure good time control of all system elements to match occupancy patterns.

Temperature control

Over-cooling is extremely wasteful. It is recommended that the cooling set point in a laboratory is not more than 3°C below the ambient temperature (subject to any more stringent laboratory equipment requirements). As such, with an ambient temperature of 27°C the cooling set point is 24°C. If the ambient temperature increases to 29°C then the cooling set point is raised to 26°C.

Key saving

Vary the cooling set point depending on ambient conditions (subject to laboratory equipment requirements).

Cooling and heating

A very common cause for waste is when the building's heating system is operating at the same time as the air-conditioning. It is, therefore, important to ensure a dead band of at least 3°C between the heating and cooling set points. This will prevent the heating and cooling systems 'fighting' each other.

Key saving

Ensure a minimum 3°C dead band between heating and cooling set points.

Communication rooms

Many communication rooms are continually air-conditioned to, say, 18°C. Many modern items of communication and computing equipment have been designed to operate at ambient conditions of up to 35°C. Some studies also indicate that cycling the temperature within communication rooms by 2°C or 3°C makes the equipment less susceptible to failure if there is a slight change in environmental conditions.

Key saving

Only air-condition if absolutely necessary.

typical saving opportunities

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

WATER USAGE

Water consumption should be analysed in the same way as that for electricity and fuel usage, ie against installed equipment and invoice information. Regular meter reading should be undertaken if invoice information is not available. This will highlight any unexplained changes in consumption and may indicate leakage.

Trigger nozzles for hoses

Hoses left running to drain are a major cause of water wastage. Sprung loaded trigger nozzles require manual operation and automatically shut off when released.

Key saving
Fit sprung loaded trigger nozzles to hoses.

Water saving devices

Tap restrictors are useful for providing equal flow at a number of taps in a wash room. Typically, they reduce water flow by up to 15%. Push taps are ideal for public areas where taps may be left running.

Key saving
Where possible, reduce water consumption at hand basins.

Urinal flush controls

Urinal flush controls limit the flushing from the traditional continually flushing cisterns. These controllers prevent water usage when urinals are unused for long periods but they include a periodic ‘hygiene’ flush.

Key saving
Fit urinal flush controls.

Waterless urinals

Waterless urinals are becoming more popular as the technology improves. They should, however, only be used where there is a reliable cleaning regime.

Key saving
Consider installing waterless urinals.

This Information Sheet forms part of ECON 83 ‘Energy use in Government Laboratories’ and has been produced by BRE’s Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

STAFF AWARENESS CAMPAIGN

There is a much greater chance of minimising energy costs if building occupants are thinking about it on a regular basis. Awareness campaigns should set out the roles and formal responsibilities of the individuals selected to achieve management targets. These tasks should be built into individual job descriptions.

Why don't people save energy?

There are five fundamental reasons why people do not save energy:

- they are not aware of the need to save energy
- they do not recognise their role
- they do not know where to save
- they do not know how to save
- they are not motivated to save.

The way to overcome some of these barriers is to change people's attitudes and give them a sense of responsibility for energy usage. By increasing their awareness and providing technical assistance this can be achieved.

Awareness techniques

There are a number of key methods that can be used to improve the awareness of staff. They are:

- talking to people (individually)
- awareness talks (groups)
- publicity ie posters, energy/ environmental display boards, newsletters etc.
- competitions
- training
- energy wardens
- regularly circulating energy performance figures.

Improving motivation

The most successful way of improving motivation is to offer some kind of incentive or reward as a bonus in people’s pay packets. Any savings may be maximised by introducing some form of interdepartmental competition. This form of competition helps to create a positive goal and promotes a team spirit amongst the participants and can also attract positive publicity. The more people that are aware, the greater the chance of reducing energy costs.

For further information please refer to GPG 84 ‘Managing and motivating staff to save energy’.

This Information Sheet forms part of ECON 83 ‘Energy use in Government Laboratories’ and has been produced by BRE’s Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

GOOD HOUSEKEEPING

8

Office equipment
Office equipment can typically account for up to 20% of the energy used in the office spaces associated with laboratories. Good management of office equipment can create worthwhile energy savings. For further information, please refer to GPG 118 'Managing energy use. Minimising running costs of office equipment and related air-conditioning' and GPG 276 'Managing for a better environment. Minimising running costs and impact of office equipment'.

Manual switching off
Staff should be encouraged to switch off equipment whenever it is not being used, providing it is cost effective to do so. This is particularly applicable to computer screens as they can be switched off while the computer itself remains on. There are, however, times when it can take too long to bring some equipment back into operation (eg large photocopiers etc) for it to be cost-effective to switch them off for relatively short periods.

Key saving

Where possible, all equipment should be switched off during lunch hours, at night and at weekends, unless specifically required, eg network servers, equipment connected to outside line modems etc.

Energy-saving features
Energy-saving features built into office equipment (eg Energy Star compliant equipment) should be enabled. These features typically include:

- automatic standby mode
- automatic switch off.

Key saving

All equipment should have energy-saving features enabled. If Energy Star equipment is purchased, it is essential that the software is set up correctly on each machine, otherwise the initial extra capital cost would have been in vain!

Popular misconceptions
'Switching off fluorescent lights costs more than leaving them switched on'

NO!

If a fluorescent light is not required, it is always more efficient to turn it off rather than leave it on.

'Computer screens in 'screen saver' mode save energy'

NO!

When a computer screen is in 'screen saver' mode it does not save any energy. Screens should be turned off rather than leaving them in screen saver mode.

'Turning off personal computers can damage the equipment and lose valuable data'

NO!

A personal computer should always be turned off when left unattended for more than, say 30 minutes. Turning it on and off does not cause damage.

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

9

REFURBISHMENTS

Energy efficiency measures can often be incorporated during refurbishment works at marginal extra cost. Such opportunities should not be missed.

Roofs

Insulating pitched roofs at ceiling level gives a good rate of return at any time.

Flat roofs should be insulated during refurbishment work.

Older buildings often have high ceilings. Installing a new false ceiling with insulation at ceiling level can reduce the heated volume.

Walls

Where external surfaces of walls require attention for structural or other reasons, insulating the wall at the same time should be considered.

Addition of insulation to the internal face of external walls should be carried out during refurbishment to minimise the potential disruption to occupants.

If internal refurbishment is to be carried out, adding insulation between timber studs or using a composite board should be considered.

Floors

Where there is access to the underside of suspended timber floors, adding insulation between the joists is cost-effective.

Where existing solid floors need to be renewed, this is an opportunity to add insulation.

Windows

Where window frames are in poor condition and need replacing, consider installing 4-12-4 double glazing with a low-emissivity (low-e) coating.

Many post-war laboratory buildings were designed with a large area of single glazing. During refurbishment, consideration should be given to replacing some of the low-level glazing with insulated panels.

Where control of solar gain is required, the installation of external shading devices should be considered.

Doors

Providing a draft lobby at frequently used entrances to a building can make a significant contribution to reducing ventilation heat loss.

Lighting

When fluorescent lighting is being replaced, consideration should be given to using high-frequency fittings.

When new lighting is being installed, ensure that all control options are considered and that sufficient manual switches are provided.

Heating

Where a building under refurbishment is a long way from a central boiler house, decentralisation may be appropriate.

Good controls are an important part of energy management. It is recommended that, as far as possible, controls are made tamper-proof and should include time switches, optimisers, compensator, TRVs, zoning, etc.

Any redundant pipework should be isolated or removed.

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

10 LABORATORY EQUIPMENT

General

Wherever possible, make sure that laboratory equipment (for example incubators) and fume cupboards, are turned off when not required.

Key saving
Turn off all equipment and fume cupboards when not required.

Ancillary services

It is also important to turn off ancillary services whenever possible to reduce energy use and maintenance requirements due to 'wear and tear'. In particular think about:

- Air compressors
- Vacuum pumps
- Demin water pumps
- Local extract fans
- Task lighting
- PC terminals (especially monitors)

Key saving
Turn off ancillary laboratory services when not required.

Sterilisers/dishwashers

Subject to hygiene requirements, energy savings can be made by ensuring that dishwashers etc. are run as full loads (rather than a larger number of part loads).

Key saving
Optimise use of sterilisers and/or dishwashers.

If a separate steam generator is used, make sure that its use is minimised by closely matching its operating times to those of the sterilisers/ autoclaves that it serves. Ensure steam distribution pipework and valves are well insulated.

Key saving
Minimise use of steam generators and ensure pipework and valves are well insulated.

Incinerators

Incinerators should always be sub-metered, both for their electricity and oil/gas usage.

If a waste heat boiler is installed, make sure that its controls are well understood and functioning properly in order to maximise heat recovery. Make sure that hot water is not circulated to the waste heat boiler when the incinerator is off as this will lead to significant heat losses.

Key saving
Ensure waste heat boiler controls are working properly to maximise heat recovery.

This Information Sheet forms part of ECON 83 'Energy use in Government Laboratories' and has been produced by BRE's Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.

CHECKLIST

11

Regular activities

- Read all utility meters, ideally monthly ☐
- Monitor consumption and compare with previous performance ☐
- Report/publish performance ☐

Checks for energy waste when a building is occupied

- Are areas suffering from overheating or excessive cooling? ☐
- Are the lights off in unoccupied areas? ☐
- Are lights off when daylight is sufficient? ☐
- Are light fittings clean? ☐
- Are windows and doors open when the heating/air conditioning is on? ☐
- Is office equipment left on at unoccupied workstations? ☐
- Are portable electric heaters in use? ☐
- Are there obstructions in front of radiators or heaters? ☐
- Are blinds being used to minimise solar gain in air conditioned areas? ☐
- Are hoses left running? ☐
- Are taps dripping? ☐
- Is external or security lighting on during daylight hours? ☐
- Are sterilisers/dishwashers being used effectively? ☐
- Are heat recovery controls working correctly (if a waste heat boiler is fitted to an incinerator)? ☐

Checks for energy waste outside normal occupancy

- Are all lights switched off? ☐
- Do cleaners switch off all lights? ☐
- Are doors and windows closed? ☐
- Are all fans switched off? ☐
- Are there any items of office equipment left on? ☐
- Are vending machines switched off? ☐
- Are laboratory equipment, fume cupboards and ancillary services (such as compressed air, vacuum etc.) turned off? ☐

For further information please refer to GPG 117 ‘Energy efficiency in the Government Estate – for accommodation managers’.

This Information Sheet forms part of ECON 83 ‘Energy use in Government Laboratories’ and has been produced by BRE’s Sustainable Energy Centre (BRESEC) for Action Energy – formerly the Energy Efficiency Best Practice programme.